

WHAT IS CLAIMED IS:

- 1 1. A method for depositing a film on a substrate in a process
2 chamber, the method comprising:
 - 3 providing a first gaseous mixture to the process chamber;
 - 4 generating a plasma from the first gaseous mixture with a plasma source
5 disposed within the process chamber to deposit a first portion of the film on the
6 substrate;
 - 7 thereafter, flowing an etchant gas into the process chamber without
8 terminating the plasma to etch part of the first portion of the film; and
9 thereafter, providing a second gaseous mixture to the process chamber
10 without terminating the plasma to deposit a second portion of the film on the substrate.
- 1 2. The method recited in claim 1 further comprising applying an
2 electrical bias to the substrate while flowing the etchant gas.
- 1 3. The method recited in claim 2 wherein the bias has a power
2 density approximately between 0.9 W/cm² and 3.2 W/cm².
- 1 4. The method recited in claim 1 wherein the second gaseous
2 mixture is substantially the same as the first gaseous mixture.
- 1 5. The method recited in claim 1 wherein the first and second
2 gaseous mixtures each include a silicon-containing gas and an oxygen-containing gas,
3 and wherein the etchant gas includes a fluorine-containing gas.
- 1 6. A method for depositing a film on a substrate in a process
2 chamber, the method comprising:
 - 3 providing a first gaseous mixture to the process chamber, the first
4 gaseous mixture comprising a first deposition gas and an etchant gas; and
5 generating a plasma from the first gaseous mixture with a plasma
6 coupling structure to simultaneously deposit a first portion of the film on the substrate
7 and etch the film, wherein the plasma includes poloidal ion flow along field lines
8 substantially parallel to a surface interior to the process chamber and disposed to
9 separate the plasma from the plasma coupling structure.

1 7. The method recited in claim 6 further comprising providing a
2 second gaseous mixture to the process chamber without terminating the plasma, the
3 second gaseous mixture comprising a second deposition gas, to deposit a second
4 portion of the film.

1 8. The method recited in claim 6 further comprising applying an
2 electrical bias to the substrate.

1 9. The method recited in claim 8 wherein the bias has a power
2 density approximately between 0.9 W/cm² and 3.2 W/cm².

1 10. The method recited in claim 8 wherein the bias has a power
2 density approximately between 0.9 W/cm² and 1.6 W/cm².

1 11. The method recited in claim 6 wherein the plasma is a high-
2 density plasma.

1 12. The method recited in claim 6 wherein the second deposition gas
2 is substantially the same as the first deposition gas.

1 13. The method recited in claim 6 wherein the first deposition gas
2 includes a silicon-containing gas and an oxygen-containing gas, and wherein the
3 etchant gas includes a fluorine-containing gas.

1 14. A computer-readable storage medium having a computer-
2 readable program embodied therein for directing operation of a substrate processing
3 system including a process chamber; a plasma coupling structure; a substrate holder;
4 and a gas delivery system configured to introduce gases into the process chamber, the
5 computer-readable program including instructions for operating the substrate
6 processing system to form a film on a substrate disposed in the process chamber in
7 accordance with the following:

8 providing a first gaseous mixture to the process chamber, the first
9 gaseous mixture comprising a first deposition gas and an etching gas;

10 generating a plasma from the first gaseous mixture with the plasma
11 coupling structure to simultaneously deposit a first portion of the film on the substrate
12 and etch the film, wherein the plasma includes poloidal ion flow along field lines

13 substantially parallel to a surface interior to the process chamber and disposed to
14 separate the plasma from the plasma coupling structure.

1 15. The computer-readable storage medium recited in claim 14, the
2 computer-readable program further including instructions for applying an electrical bias
3 to the substrate.

1 16. The computer-readable storage medium recited in claim 14, the
2 computer-readable program further including instructions for providing a second
3 gaseous mixture to the process chamber without terminating the plasma, the second
4 gaseous mixture comprising a second deposition gas, to deposit a second portion of the
5 film.

1 17. A computer-readable storage medium having a computer-
2 readable program embodied therein for directing operation of a substrate processing
3 system including a process chamber; a plasma generation system having a plasma
4 source disposed within the process chamber; a substrate holder; and a gas delivery
5 system configured to introduce gases into the process chamber, the computer-readable
6 program including instructions for operating the substrate processing system to form a
7 film on a substrate disposed in the process chamber in accordance with the following:

8 providing a first gaseous mixture to the process chamber;
9 generating a plasma from the first gaseous mixture with the plasma
10 source;

11 thereafter, flowing an etchant gas into the process chamber without
12 terminating the plasma to etch part of the first portion of the film; and

13 thereafter, providing a second gaseous mixture to the process chamber
14 without terminating the plasma to deposit a second portion of the film on the substrate.

1 18. The computer-readable storage medium recited in claim 17, the
2 computer-readable program further including instructions for applying an electrical bias
3 to the substrate while flowing the etchant gas.

1 19. A substrate processing system comprising:
2 a housing defining a process chamber;
3 a plasma generating system operatively coupled to the process chamber
4 and including a plasma coupling structure disposed within the process chamber;

1 21. The substrate processing system recited in claim 19, the
2 computer-readable program further including instructions for providing a second
3 gaseous mixture to the process chamber without terminating the plasma, the second
4 gaseous mixture comprising a second deposition gas, to deposit a second portion of the
5 film.

1 22. A substrate processing system comprising:
2 a housing defining a process chamber;

3 a plasma generating system operatively coupled to the process chamber,
4 the plasma generating system including a plasma source disposed within the process
5 chamber;

6 a substrate holder configured to hold a substrate during substrate
7 processing;

8 a gas-delivery system configured to introduce gases into the process
9 chamber, including sources for a silicon-containing gas, a fluorine-containing gas, and
10 an oxygen-containing gas;

11 a pressure-control system for maintaining a selected pressure within the
12 process chamber;

13 a controller for controlling the plasma generating system, the gas-
14 delivery system, and the pressure-control system; and

15 a memory coupled to the controller, the memory comprising a computer-
16 readable medium having a computer-readable program embodied therein for directing
17 operation of the substrate processing system, the computer-readable program including
18 instructions to control the gas-delivery system to provide a first
19 gaseous mixture to the process chamber;

20 instructions to control the plasma generating system to generate a
21 plasma from the first gaseous mixture with the plasma source to deposit a first portion
22 of the film on the substrate;

23 instructions to control the gas-delivery system to flow, thereafter,
24 an etchant gas into the process chamber without terminating the plasma to etch part of
25 the first portion of the film; and

26 instructions to control the gas-delivery system to provide,
27 thereafter, a second gaseous mixture to the process chamber without terminating the
28 plasma to deposit a second portion of the film on the substrate.

1 23. The substrate processing system recited in claim 22, the
2 computer-readable program further including instructions for applying an electrical bias
3 to the substrate while flowing the etchant gas.